

Wireless Communications

5G MOBILE NETWORK INFRASTRUCTURE TESTING

T&M solution guide for network
infrastructure equipment providers

ROHDE & SCHWARZ

Make ideas real



Radio access networks (RAN) are deployed with different kinds of infrastructure equipment. They range from macro to small cell base stations and include distributed antenna systems, repeaters, base station antennas, radios and mobile backhaul.

THE FUTURE OF MOBILE NETWORK INFRASTRUCTURE

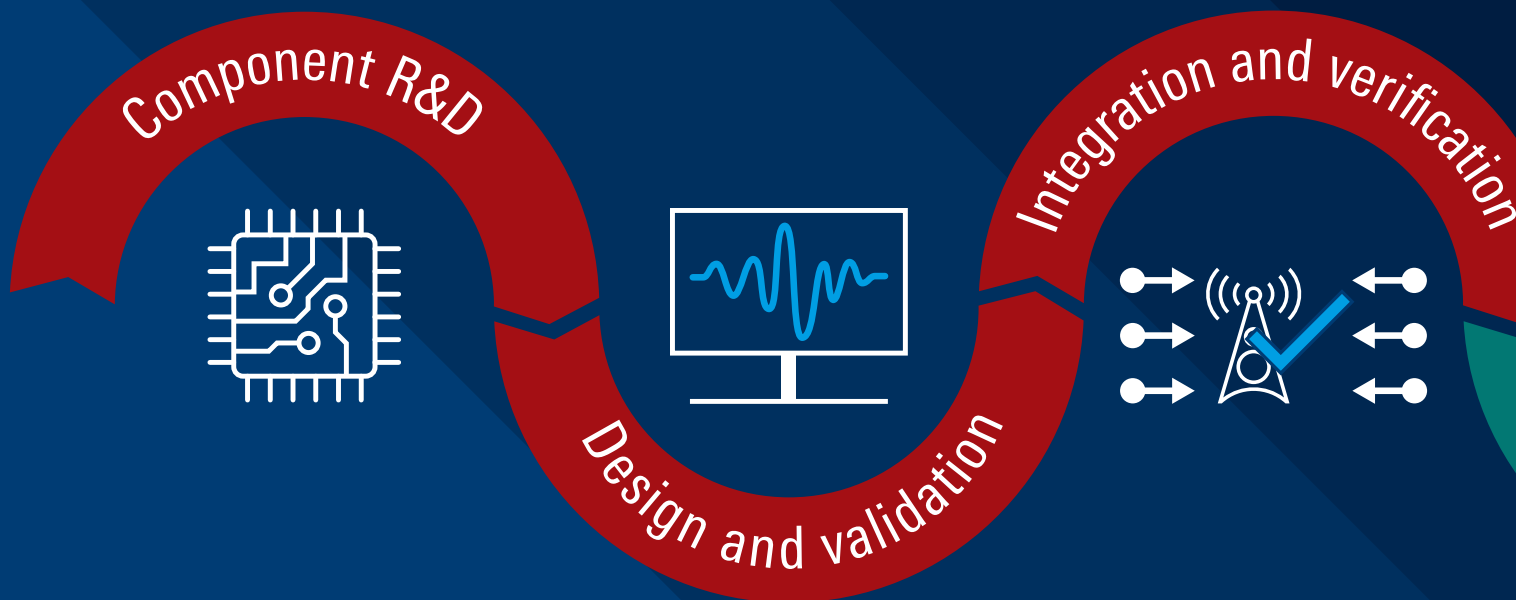
Constantly evolving technology up to 5G and beyond, new data-hungry use cases and the ever-present demand for economic efficiency are drivers of the mobile network infrastructure equipment industry. Particularly 5G NR challenges network infrastructure equipment testing due to increasing MIMO complexity and beamforming, over-the-air testing, wider bandwidths and new spectrum bands up to mmWave. The industry moving towards an open and virtualized network architecture to foster innovation, combined with faster time to market, poses significant test and measurement challenges across all phases of the product test cycle from component R&D of RF as well as digital and power design, design validation and integration to conformance and production testing.



SIGNIFICANCE OF R&D TESTING

Component characterization is an important phase in the lifecycle of 5G infrastructure equipment design. It requires measurement systems offering wide frequency coverage, wide bandwidth, high dynamic range, high output power, spectral flatness and high signal quality. Besides testing of RF components, development of wireless network equipment also comprises verification of the digital signal processing and power modules. During the design and

validation phase, the functional performance is verified over a wide range of conditions. The power and modulation performance of components and transmitters as well as the beamforming accuracy and signal integrity over high speed interfaces is included. The focus during integration and verification is on feature sets and the completeness of tests, such as spherical radiation pattern, total radiated power, transmitter characteristics and receiver performance as well as a broad performance analysis.



LONG-TERM T&M RELIABILITY

Calibration and repair services ensure total functionality, business continuation and accuracy of T&M instruments for the years to come.

Calibration performed by the manufacturer based on manufacturer-defined calibration routines ensures accuracy, repeatability and reproducibility of the measurement

results. Optimal maintenance of high-end test equipment and avoidance of downtime are essential to keep project targets on budget and within the intended quality level. Predefined calibration intervals for T&M instruments keep your schedules and tasks on track. Tailored software maintenance for your T&M equipment leads to robustness, availability and accuracy over time.

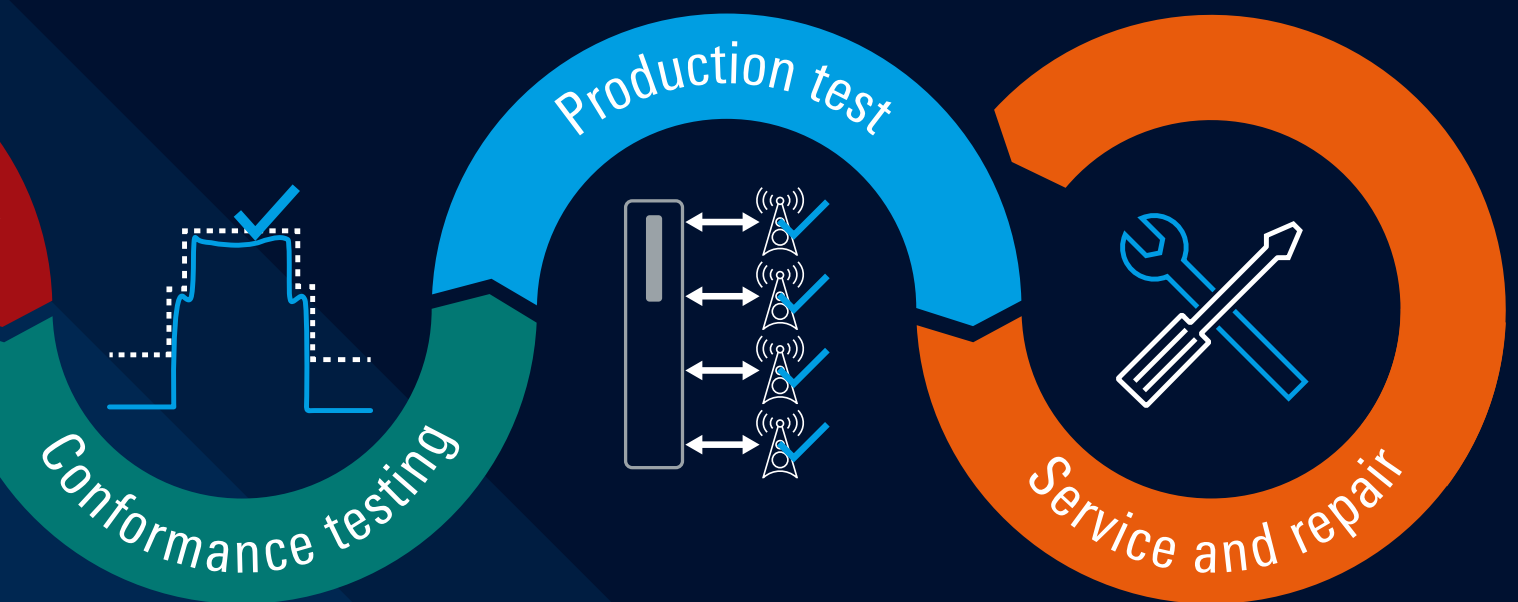
NEED FOR CONFORMANCE

The 3GPP mobile communications standardization organization specifies conformance tests to ensure that base stations operate within well-defined RF and performance constraints. Based on these 3GPP conformance tests, regional standardization bodies, local regulators and network operators implement test standards according to their own requirements. The O-RAN ALLIANCE defines conformance specifications to verify the interoperability of network equipment from different vendors.

PRODUCTION TESTING

Production test solutions for calibration and verification of subsystems and complete systems ensure final product quality. Maximum output and optimum yield are critical in production environments. Thus, high speed instruments with excellent accuracy and repeatability combined with compact footprints are fundamentally required for production test solutions.

Production tests are also increasingly parallelized and automated. Efficient and fast testing is essential by reducing test time while maintaining quality.



RF DESIGN VERIFICATION

Wider bandwidth and higher carrier frequencies up to mmWave make development of RF components, modules or complete radio equipment very challenging. Broadband test solutions are needed with excellent RF performance even in the mmWave range to master these challenges. A wider carrier bandwidth of up to 100 MHz for 5G FR1 and typically 400 MHz for 5G FR2 plus carrier aggregation up to 1.6 GHz makes test solutions supporting wideband signal generation and analysis a must.

The 5G physical layer offers a degree of flexibility never seen before with a multitude of parameter options and combinations, requiring dedicated solutions to simplify signal configuration for generation and analysis.

FUTURE-PROOF RF TESTING

With its outstanding phase noise performance, flat frequency response within the RF modulation bandwidth over the whole supported frequency range and excellent modulation characteristics, the R&S®SMW200A vector signal generator is a perfect tool for the most demanding test applications. It is designed to generate complex, digitally modulated signals of high quality.

The R&S®FSW signal and spectrum analyzer with its extremely wide dynamic range enables outstanding EVM performance. It perfectly meets specific 5G NR test requirements and offers superior RF performance in terms of phase noise along with the best sensitivity with built-in demodulation bandwidth of up to 8.3 GHz.



The R&S®SMW200A generates signals up to 67 GHz with an internal modulation bandwidth up to 2 GHz, and 4 GHz with the bandwidth extension option.

EXCELLENT PERFORMANCE WITHOUT COMPROMISE

The R&S®SMM100A mid-range vector signal generator and R&S®FSVA3000 mid-range spectrum analyzer are well-suited for many 5G NR test applications. They are ideal choices where a good price/performance ratio is a key factor.

The R&S®SMA100B analog signal generator delivers an extremely pure signal with the highest output power up to 67 GHz for all 5G applications requiring very clean analog signals.

Expert tip

Easily extend the frequency range of Rohde & Schwarz signal generators and signal and spectrum analyzers up to 50 GHz with R&S®FExx external frontends. These frontends enable upconversion and downconversion of the signal directly at the device under test. In an over-the-air environment, this results in lower cable losses, higher sensitivity and more power to the antenna.



Analyze wideband signals with the R&S®FSW internal bandwidth of up to 8.3 GHz.

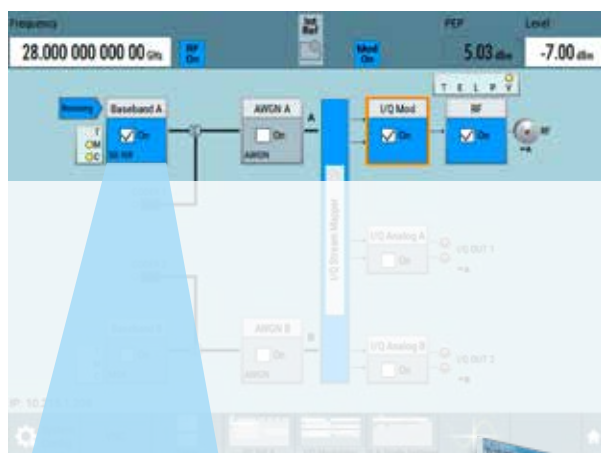
SIMPLER AND FASTER SIGNAL GENERATION AND ANALYSIS

Rohde&Schwarz offers dedicated applications for generating and analyzing 5G signals to simplify your test setup. 3GPP standard-compliant 5G NR signals can be configured directly on Rohde&Schwarz vector signal generators or using the R&S®WinIQSIM2 software.

Powerful signal analysis applications running directly on Rohde&Schwarz signal and spectrum analyzers provide deep insights, displaying a wide array of performance metrics. The R&S®VSE vector signal explorer PC software brings these powerful signal analysis capabilities to the desktop.

Besides many other digital standards, a generic OFDM solution is also available to generate and analyze user-defined OFDM signals.

Both the Rohde&Schwarz signal generators and the spectrum and signal analyzers are designed for excellent interworking, e.g. 5G NR settings can be easily transferred with a click of a button from the generator to the analyzer or vice versa.



Configure standard-compliant 5G NR signals with R&S®WinIQSIM2 software.



Analysis of 5G NR downlink signal with R&S®VSE vector signal explorer.

HIGHEST ACCURACY WITH EASE

The most suitable test tool for verifying the performance of network infrastructure, antennas and radio components is a vector network analyzer such as the R&S®ZNA. It handles challenging measurements with ease while providing outstanding accuracy, dynamic range and speed. The R&S®ZNA family covers a broad frequency range up to the 5G NR mmWave spectrum.

Featuring a wide range of hardware and software options, the R&S®ZNA is an integrated solution that can even perform comprehensive active device characterization.

Expert tip

The R&S®ZNA vector network analyzer with up to four internal phase coherent sources in combination with R&S®BBA300 ultrawideband amplifiers forms the ideal setup for fast and accurate passive intermodulation (PIM) measurements. With a broad frequency range of 380 MHz to 6 GHz and linear RF output power of up to 300 W, the R&S®BBA300 family makes it easy to obtain stable signals at high power levels to specifically address infrastructure network components like antennas or filters.



R&S®ZNA high-end vector network analyzer series covering up to 67 GHz.

TESTING YOUR DIGITAL & POWER DESIGN

Ever increasing data rates are driving the integration of high speed interfaces, requiring reliable signal integrity analysis tools to rapidly collect data for statistical analysis and accurately measure channel characteristics on PCBs and interconnects.

Dense designs involving mixed technologies and increasing numbers of power rails are driving the need for power integrity testing to verify power quality and debug disturbances.

The increasing number of converters and power management ICs implemented in sophisticated highly integrated designs requires appropriate characterization of power efficiency and debugging of power electronics.

FAST AND RELIABLE – FOR ALL DIGITAL INTERFACES

The integration of high speed digital interfaces requires advanced signal integrity tests for debugging, verification and compliance testing. The R&S®RTP high-performance oscilloscope is designed for extremely detailed jitter decomposition as well as highly versatile TDR/TDT analysis. Users enjoy high statistical confidence with its ultra-fast, real-time eye diagram analysis.

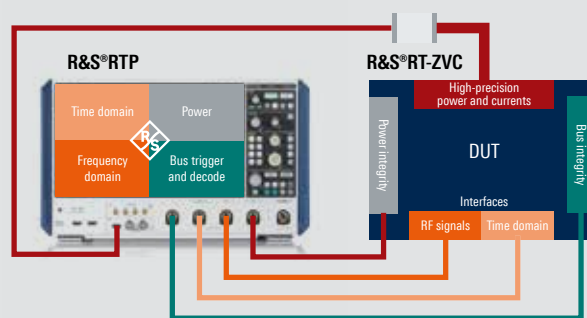
Measure channel characteristics of high speed PCBs and interconnects with the R&S®ZNA and R&S®ZNB vector network analyzer family. These instruments are designed for accurate frequency and time domain analysis and support advanced functionality such as eye diagram analysis and (de)embedding tools for in-fixture and on-board testing.

ACCURATE AND FLEXIBLE POWER ANALYSIS

Power designs are moving towards faster edge rates. The R&S®RTE and R&S®RTO6 high-resolution oscilloscopes support up to 16-bit vertical resolution, making characterization and debugging of power supplies highly efficient. The comprehensive R&S®RT-ZHD high-voltage differential probe portfolio with its large differential and common mode range, as well as high common mode rejection across the bandwidth, is intended to address your specific needs.

Expert tip

Combine multiple measurements from different device interfaces on the same screen by using the advanced R&S®RTP oscilloscope in combination with the R&S®RT-ZVC multi-channel power probe. Use multidomain analysis for system-level debugging – the perfect solution for determining causes of signal anomalies.



The R&S®RTP supports unique real-time signal integrity analysis from 4 GHz to 16 GHz.



The R&S®ZNB is the leader in speed, dynamic range and ease of operation in the frequency range 100 kHz to 43.5 GHz.



Rohde & Schwarz offers a comprehensive probe portfolio.

ACHIEVING ENERGY EFFICIENCY WITH POWERFUL T&M SOLUTIONS

The bulk of energy consumption in a mobile network occurs in the RAN components. There, the base stations and radio units play a substantial role.

Thus, it is essential to verify and optimize the energy efficiency of radio equipment during the development process.

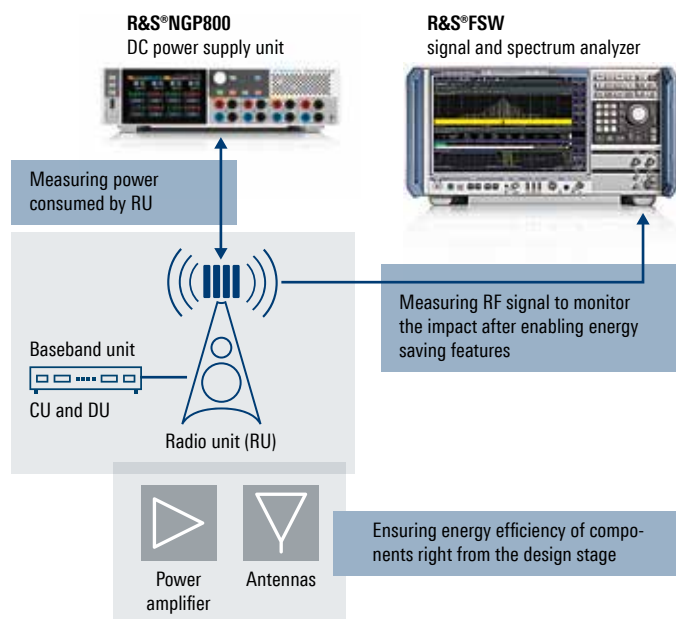
FROM POWER STATISTICS TO ADVANCED ANALYSIS

The R&S®NGP800 power supply series provides up to 800 W on up to four independent channels. Remote control is also supported. Built-in measurements simplify the setup process and reduce the need for an external multimeter. The integrated statistics show the min./max. and average values for power, voltage and current as well as an energy count. Connect up to four channels in serial or parallel to obtain up to 250 V or 80 A.

You can monitor the output spectrum and any impact due to input power supply variations with the R&S®FSW signal and spectrum analyzer.

Expert tip

Optimize energy efficiency by debugging device activity versus power consumption. Using a sophisticated R&S®RTP or R&S®RTO6 oscilloscope from Rohde & Schwarz together with the R&S®RT-ZVC 18-bit multi-channel power probe, it is possible to analyze eight voltage and current signals in parallel with a wide dynamic range.



Advanced power analysis



R&S®NGP800 power supply series with up to four channels providing up to 800 W, 250 V or 80 A.

MULTI-CHANNEL SIGNAL GENERATION AND ANALYSIS

MIMO stands for “multiple input multiple output”. Involving several technologies, it mainly describes spatial multiplexing, i.e. a wireless network that can transmit and receive more than one data signal layer simultaneously over the same radio channel. Massive multiple input multiple output (MIMO) antenna systems and beamforming are no doubt two of the compelling technologies facilitated by 5G NR.

5G NR MIMO SIGNAL GENERATION

Generate up to $nx8$ MIMO signals by combining the dual-channel R&S®SMW200A signal generator with up to six R&S®SGT100A RF sources.



Expert tip

The integrated fading simulation on the R&S®SMW200A allows cost-effective verification that your MIMO receiver is able to meet performance requirements under real-world conditions.

5G NR MIMO SIGNAL ANALYSIS

Determining the phase difference between MIMO data streams is essential in order to benchmark the quality of the generated beamforming.

Rohde & Schwarz offers two solutions for phase coherent multi-channel measurements.

The R&S®RTP and R&S®RTO6 oscilloscopes are well-suited to address applications with up to four data streams. R&S®NRQ6 setups can scale up to 64 channels.

Use the full instrument bandwidth of Rohde & Schwarz oscilloscopes, or use the R&S®NRQ6 to measure a larger number of channels with up to 100 MHz bandwidth per channel.

Together with the R&S®VSE vector signal explorer software, they combine to form an easy-to-use test solution for 5G NR MIMO signal analysis.



5G MIMO analysis using R&S®VSE.



The high-performance R&S®SMW200A signal generator can be configured as a dual-path instrument up to 44 MHz.



R&S®RTP oscilloscopes with up to four phase coherent channels for 5G FR1 NR multi-channel analysis in combination with R&S®VSE-5G MIMO analysis software.



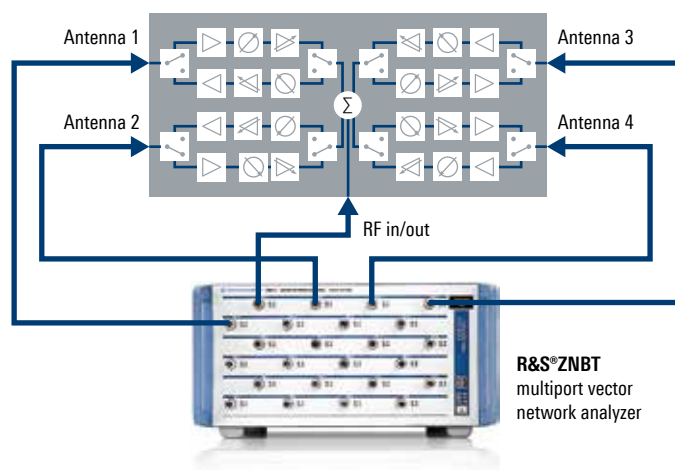
R&S®NRQ6 power sensors and R&S®VSE-5G MIMO analysis software for 5G FR1 MIMO signal analysis.

VERIFY BEAMFORMING ACCURACY

5G employs massive MIMO and beamforming to combat the effects of higher attenuation at higher frequencies and to improve capacity. In particular, beam steering and beam sweeping are important techniques to cope with the dynamic nature of the wireless channel. Test solutions need to offer a simple way to characterize beamforming components and to verify the accuracy of beamforming and the effectiveness of beam steering techniques.

THE TRUE MULTIPORT VNA

The R&S®ZNBT – a true multiport VNA – is an ideal choice for verifying beamformer ICs. It allows simultaneous measurement of up to 24 ports with a single instrument. Parallel connection to all of the beamformer IC's RF ports allows fast and direct evaluation of all individual channels along with the relative behavior in the beamformer IC.



The R&S®ZNBT multiport vector network analyzer is a platform for challenging multiport measurements. Frequency ranges are available up to 40 GHz.

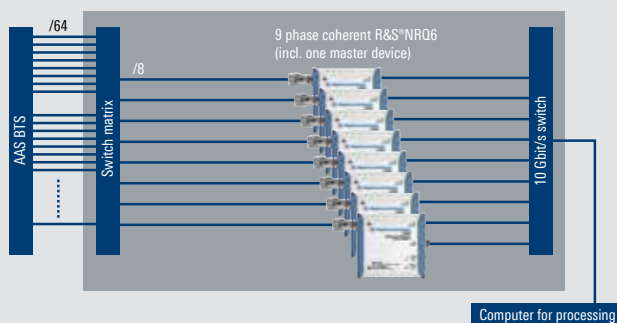
EXTREMELY ACCURATE OTA POWER MEASUREMENTS

The R&S®NRPM is a fully calibrated and individually scalable OTA power measurement solution for benchtop applications or in anechoic chambers. Covering a frequency range from 18 GHz to 90 GHz, it is a perfect tool for over-the-air (OTA) multidimensional beamforming verification and calibration of transmit antenna output power.

Power is measured directly at the antenna. No complicated system calibration by the user is necessary.

Expert tip

Use the scalable setup of R&S®NRQ6 power sensors combined with R&S®OSP switch matrixes for real-time beamforming verification supporting up to 64 RF ports.



The R&S®NRPM OTA power measurement solution consists of R&S®NRPM-A90/R&S®NRPM-A90D antenna modules and the R&S®NRPM3 sensor module.

OVER-THE-AIR TESTING TO MEET YOUR NEEDS

Due to the inaccessibility of connectors in mmWave frequency ranges, conducted testing is basically impossible. Over-the-air (OTA) testing is also the default use case for massive MIMO where traditional RF output ports are no longer accessible. This means that features such as beam-forming can only be tested over the air.

CHAMBERS FOR ALL TEST PURPOSES

Rohde&Schwarz has long-standing experience in over-the-air testing with a complete solution portfolio for near field (NF), direct far field (DFF) and indirect far field (IFF) measurements. This includes the wireless performance test chamber (WPTC) series that supports the frequency range from 400 MHz to 90 GHz and allows full 3D characterization by means of a conical cut positioning system. The chambers feature high shielding effectiveness of up to 100 dB and are available in five different sizes ranging from approx. 2.7 m maximum side length (XS) to approx. 5.8 m (XL).

Expert tip

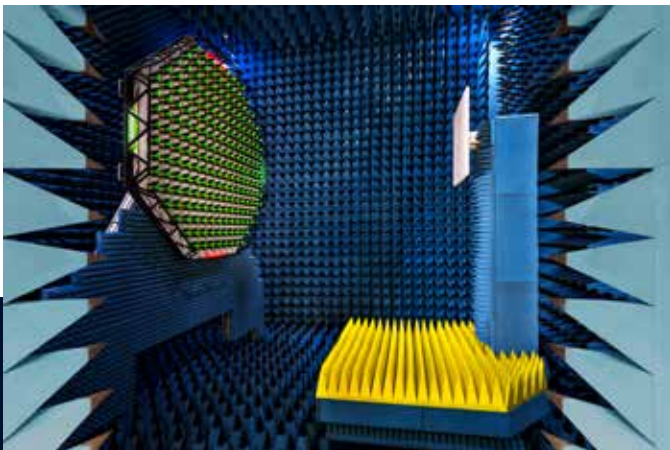
Plane wave synthesis (PWS) is a recognized methodology for 3GPP base station testing (TR 37.941). It provides a large quiet zone (QZ) size at a very short measurement distance.

PRECISE MEASUREMENTS WITH SMALL TEST CHAMBER FOOTPRINTS

The R&S®PWC200 plane wave converter is an outstanding solution for verifying massive MIMO infrastructure equipment within the FR1 frequency range from 1.7 GHz to 5 GHz. It is based on a bidirectional array of 156 wideband Vivaldi antennas placed in the radiating near field of the device under test (DUT). The phased antenna array forms planar waves inside a specified quiet zone encompassing the DUT for real-time radiated power and transceiver measurements (as required by 3GPP TS 38.141-2 radiated base station conformance testing).

The R&S®PWC200 can shrink the required chamber footprint to 10 % compared to a direct far field and 50 % compared to a CATR chamber solution covering the same quiet zone size.

The R&S®ATS1800C CATR fully shielded test chamber provides a compact environment for testing 5G FR2 radio equipment. CATR stands for compact antenna test range. It uses hardware to transform spherical waves into plane waves creating far-field conditions at considerably less than the Fraunhofer distance. While covering a wide frequency range of 23 GHz to 90 GHz, the R&S®ATS1800C occupies a footprint of only 1.3 m² and provides a quiet zone diameter of up to 40 cm.



The small-footprint R&S®PWC200 is optimized to verify massive MIMO devices in FR1.



The compact R&S®ATS1800C mmWave chamber.

VERIFY THE 3GPP CONFORMANCE OF YOUR BASE STATION

The 3GPP mobile communications standardization organization specifies conformance tests to ensure that base stations operate within well-defined RF and performance constraints. The conformance tests defined by 3GPP in the TS 38.141 specification cover transmitter and receiver characteristics as well as receiver performance under noise and fading conditions, applied to conducted and radiated over-the-air testing.

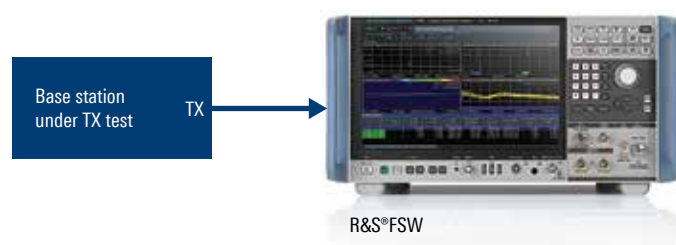
| | 5G NR 3GPP specification |
|-------------|---|
| TS 38.104 | Base station (BS) radio transmission and reception |
| TS 38.141-1 | BS conducted conformance testing chapter 6, 7 and 8 |
| TS 38.141-2 | BS radiated conformance testing chapter 6, 7, 8 (OTA) |

There are three different base station (BS) types defined by 3GPP: conducted (BS type 1-C), hybrid (BS type 1-H) and OTA/radiated (BS type 1/2-O).

A COMPREHENSIVE TESTING SOLUTION

The R&S®SMW200A vector signal generator with its high output power and wideband signal generation capability serves as an excellent signal source for conducted and over-the-air testing of receivers and antenna modules. With wide analysis bandwidth and powerful analysis capabilities, the R&S®FSW signal and spectrum analyzer is an outstanding companion for testing transmitters and receiver spurious emissions.

With the help of the user-defined frequency response correction option available on the Rohde & Schwarz vector signal generators and signal and spectrum analyzers, the reference plane for measurements can be shifted from the RF output / input of the instruments to the link and measurement antennas. This allows the true performance of the DUT to be measured in both benchtop and shielded OTA measurement setups.



Setup for testing base station transmitter characteristics with the R&S®FSW signal and spectrum analyzer with its wide analysis bandwidth and powerful analysis capabilities.

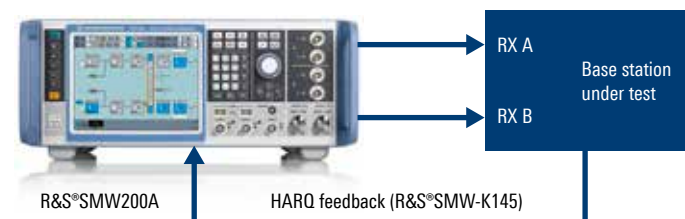
When equipped with the optional fading simulator, the R&S®SMW200A turns into a single-box solution for performance testing. The R&S®SMW200A is able to generate the specified wanted and interference signals, perform fading using presets for the corresponding channel models, add AWGN and provide the real-time HARQ feedback signals required for 3GPP TS 38.141-1/2 Chapter 8 testing.

PREPARED FOR OTA

Rohde & Schwarz offers a broad range of shielded RF boxes and chambers to perform radiated over-the-air 3GPP conformance testing, including optimized small footprint solutions like the R&S®PWC200 for FR1 applications and R&S®ATS1800C for measurement in the mmWave frequency range.

Expert tip

Simply use the test case wizard that comes with the 5G NR signal generation option to quickly configure the relevant test cases specified in 3GPP TS38.141, e.g. by using built-in presets for the uplink fixed reference channels (FRC) and downlink test models (TM).



Setup for testing base station receiver characteristics and performance with the R&S®SMW200A single-box solution as an excellent signal source with optional fading simulator.

VERIFY THE O-RAN CONFORMANCE OF YOUR O-RU

The evolution of Open RAN is making radio access networks more open, disaggregated and flexible.

Opening the network architecture can foster innovation, accommodate individual needs and enhance network efficiency. However, it also brings new challenges in terms of interoperability between the network equipment of different vendors. Testing this equipment is crucial to ensure interoperability between components from different vendors and to deliver the same customer experience as with traditional RAN.

The O-RAN ALLIANCE specifies O-RAN fronthaul (FH) conformance test cases in their ORAN.WG4.CONF specification.

AN INTEGRATED TEST SETUP

Together with VIAVI Solutions, Rohde & Schwarz offers a proven, powerful test solution to verify the FH conformance of your O-RU radio unit.

The VIAVI TM500 O-RU tester (O-DU emulator) synchronizes and configures the O-RU. Rohde & Schwarz signal generators and signal and spectrum analyzers, such as the R&S®SMW200A and R&S®FSW, provide RF signals and waveforms, capture signals and analyze the I/Q data both on the uplink and downlink.

The VIAVI O-RU test manager application (O-RU TMA) provides a clear pass/fail overview for the main parameters. For in-depth debugging, customers can use the R&S®VSE vector signal explorer analysis software to access detailed measurement results.

A COMPREHENSIVE SOLUTIONS PORTFOLIO

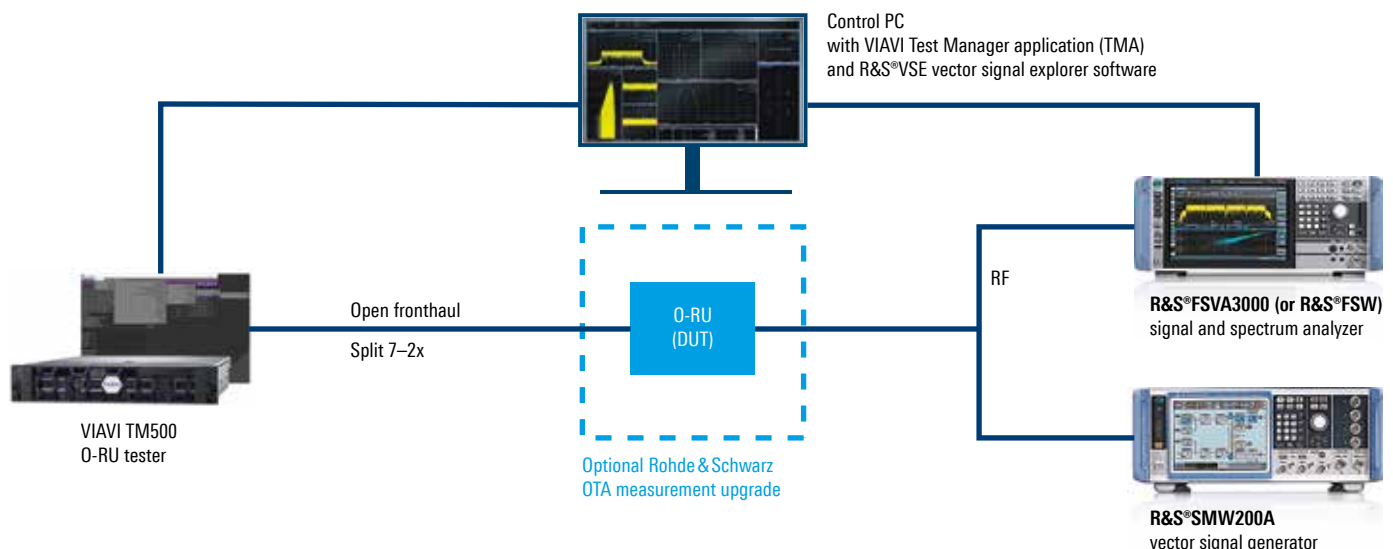
Rohde & Schwarz provides a broad portfolio of test solutions for Open RAN from design and conformance to production and end-to-end testing.



Expert tip

The central VIAVI O-RU test manager application (O-RU TMA) simplifies O-RU conformance testing.

Select the test case you want to run and the test manager will automatically trigger the appropriate configurations on the O-RU under test and the measurement instruments.



The integrated O-RAN fronthaul conformance test platform combining VIAVI and Rohde & Schwarz expert solutions.

OPTIMIZE HIGH-VOLUME AND PRODUCTION TESTING

With evolving technology and new use cases, the product variety of mobile network infrastructure equipment is ever increasing. Verifying equipment not only in R&D, but also in production, is becoming more complex. Future-proof T&M solutions are needed to make testing in high-volume and production environments more efficient.

NO COMPROMISE ON PERFORMANCE

The R&S®SGMA family of vector signal generators (i.e. R&S®SGT100A, R&S®SGS100A and R&S®SGU100A) and the R&S®FSVA3000 signal and spectrum analyzer have been developed with both size and test speed in mind, but without compromising on performance. The result is a significant reduction in test time and floor space, making them the ideal instruments for production environments.

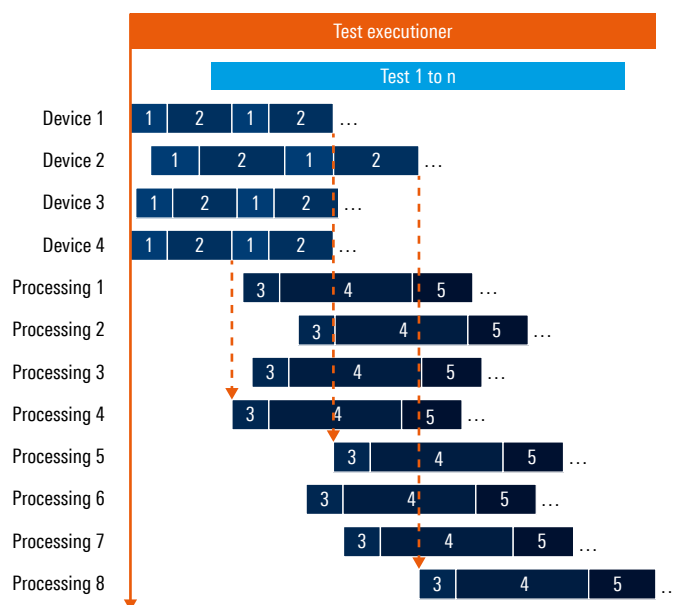
FULLY INTEGRATED

Profit from Rohde&Schwarz small-footprint testing solutions combining vector signal generator and vector analyzer in one instrument and making parallel testing of multiple devices possible. The R&S®PVT360A provides excellent EVM performance and up to +8 dBm output power while covering up to the entire FR1 frequency range. The R&S®CMP200 is a reliable and efficient instrument to test your FR2 small cell. Both solutions can be integrated in the R&S®WMT wireless manufacturing test suite: dedicated modular production automation software with a focus on speed, parallel testing and accuracy for optimum yield.

INCREASE TEST EFFICIENCY AND FLEXIBILITY

Actively managing test time and costs while maintaining quality is more important than ever before.

Parallel execution of test jobs using fast RF equipment together with multithreaded optimized signal processing based on our R&S®SBT server based testing routines results in significant speed improvements and offers scalability for better instrument utilization.



Expert tip

For power level calibration, the R&S®NRQ6 offers a compact solution for fast, highly accurate frequency selective power sensing and I/Q data capture in a single instrument.



The R&S®SGMA vector signal generators and the R&S®FSVA3000 signal and spectrum analyzer are optimized for speed without compromising on performance.



The fully-integrated R&S®PVT360A for testing FR1 mobile network infrastructure equipment.



The R&S®CMP200 in combination with R&S®CMPHead30 for testing of FR2 small cells.

ENSURE RELIABILITY THROUGH T&M MAINTENANCE

A reliable partner who has a clear understanding of what matters to customers is essential. The ideal partner supports network infrastructure players through all phases of the product lifecycle and assists with a dedicated and broad portfolio of services.

All service solutions must ensure absolute reliability and precision of your T&M instruments while allowing tailoring to meet the specific needs of the users.

WE UNDERSTAND YOUR OBJECTIVES



Controlling service costs

We want to help you control your costs. With our concepts, you will not be hit with extra service costs when a problem arises – a real benefit in the long term. For a fraction of the purchase price, you can rest easy for years. To ensure you fully benefit from the functionality and precision of your instruments for the longest possible time, we offer a range of services tailored to your specific needs. Our protection concepts offer cost control while giving you full service from the start.



Ensuring uptime utilization

Our services help you increase uptime, reduce downtime and maximize utilization. We employ standardized test systems and technologies to make your instruments perform like new in the shortest time possible. With our preventative maintenance approach, we ensure that your instruments will always deliver the performance you need.



Managing cost of ownership

Operation of your instruments can result in costs you did not originally factor in. Our comprehensive service solutions make it easy for you to keep an eye on your operating costs. Our knowledgeable representatives will help you quickly find the right services for your business requirements. Knowing that your instruments are always working to their full potential allows you to focus on your core business.



Ensuring quality

Lasting functionality and availability are fundamental to profitable operations. Regular maintenance and calibration of your Rohde & Schwarz instruments ensure dependable workflows that maintain precision even after many years. Make sure that your instruments are regularly checked and adjusted with our calibration and repair service solutions. You can rely on top precision and be confident that everything will go according to plan, now and in the future.



Keeping purchase prices transparent

With highly complex instruments or systems, it is not always possible to avoid problems. As the manufacturer, we are thoroughly familiar with the special features of our products and know where to look if there is a problem. Our service contracts keep the overall costs for your product transparent and stable at all times. In addition, our standard price repair service offers you comprehensive solutions featuring guaranteed all-inclusive fixed prices, little handling effort and efficient procedures.



Preserving your investment

In order to keep your T&M system components in a robust state and ensure the availability and accuracy your project needs, Rohde & Schwarz offers software maintenance for your investments. Regular corrective software updates and related proactive notifications of improved firmware and application software are accessible via our support portal. In case of incidents, our technical support experts around the globe will analyze your equipment and deliver support from an equipment end-to-end perspective, covering hardware and software components to minimize downtimes.

MASTERY OF EXCELLENCE

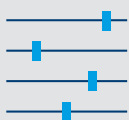
3500 service employees

11 mix and match services

200 online tutorials launched

MANUFACTURER CALIBRATION LEADS TO SUSTAINABLE QUALITY

Instruments are put through their paces, ensuring performance you can rely on. Have a look at the benefits of calibration that is performed by the manufacturer.



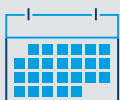
INSTRUMENT ACCURACY

In terms of accuracy, a calibration service has to consider past developments and also think proactively (upcoming challenges, evolving technologies). The right calibration partner lets you truly rely on your instrument.



CONFIDENCE IN CALIBRATION

Quality calibration performed by your manufacturer minimizes the risk of callbacks. Ultimately, undetected faults can be very costly.



LOWER CALIBRATION FREQUENCY

Calibration performed by the manufacturer helps ensure that maintenance is carried out regularly at the correct intervals. Instruments benefit from this in the form of longer calibration intervals and increased reliability.



SHORTER DOWNTIMES

Things happen. But if they happen at the Rohde & Schwarz calibration center, you can be sure that help is not far away. Avoid the risk of additional downtime and twice the expense.



**Over
70**
service and
sales locations

1600
accreditations
worldwide

1 calibration
partner

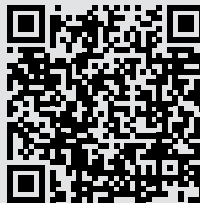
500
spare
parts stocked



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- ▶ Long-term dependability

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The Rohde & Schwarz technology group is among the trailblazers when it comes to paving the way for a safer and connected world with its leading solutions in test & measurement, technology systems and networks & cybersecurity. Founded more than 85 years ago, the group is a reliable partner for industry and government customers around the globe. The independent company is headquartered in Munich, Germany and has an extensive sales and service network with locations in more than 70 countries.

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Sustainable product design

- ▶ Environmental compatibility and eco-footprint
- ▶ Energy efficiency and low emissions
- ▶ Longevity and optimized total cost of ownership

Certified Quality Management
ISO 9001

Certified Environmental Management
ISO 14001

Rohde & Schwarz training

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